addition to the sea water of different vitamins with selected trace elements.

Gas exchange, in relation to metabolic requirements will be considered in relation to the above, utilizing closed circulating systems.

To determine the effect of varying degrees of light on the growth and survival of larval stages, one series of development containers will be subjected to complete darkness, one series to semi-darkness and one to normal diurnal light fluctuations. From overhead fluorescent lighting another series of development containers will be exposed to continuous light. These tests will be repeated a number of times in order to evaluate the survival and growth of each population.

Evaluation of the effects of the above variables will be made separately and in combination. It is recognized that other environmental factors may interact, but throughout this study, emphasis will be placed on the above cited variables.

As pointed out earlier, while our work will be primarily concerned with the larval stages, when sponge bearing females are available, we anticipate interim studies on the adult females. These crabs will be held under controlled temperatures and salinities to determine if the development and hatching of eggs can be influenced.

Concurrent with the laboratory work, it seems advisable to collect field data with which we can attempt to test our laboratory findings. Thus, the Newport and Neuse Rivers will be sampled periodically for larval and juvenile crabs along with the collection of hydographic data. Tagging of adult crabs in these two rivers will be conducted to obtain an understanding of the dynamics within the population. In particular, we are interested in the distribution and movement of the local stock.

We realize that certain phases of this work or related projects have been undertaken in various laboratories along the Atlantic Coast. Thus, we plan to continue periodic visits to these laboratories to obtain further ideas and suggestions which may be helpful in carrying on this project.

It is felt that these studies may give us a better understanding of the influences exerted by environmental factors on phases in the life cycle of the blue crab. Furthermore, the data obtained will be subjected to appropriate statistical analyses in order to determine the relationship between changes in the environmental factors and periodic fluctuations, then this may prove to be a basis for devising methods of predicting years of abundance and scarcity for the blue crab fishery.

The Role of River Basin Studies in the Conservation of Fishery Resources

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IT IS THE JOB of River Basin Studies in the U. S. Fish and Wildlife Service, Department of the Interior, to see that the interests of fish and wildlife conversation are protected in the nation's program of water resource development. This is a large order.

During the current fiscal year, the Corps of Engineers is operating, con-

structing, or planning 790 projects under an annual budget of $636,000,000. The Bureau of Reclamation is operating, constructing, or planning 145 projects with an annual budget of $180,000,000. The Department of Agriculture, in cooperation with local groups of farmers, is assisting in the construction or planning of 288 small watersheds and a number of other flood-control or water-use projects under an annual budget of $39,070,000.

These figures, impressive though they are, add up to only a part of the picture. Applicants, permittees, and licensees under the Federal Power Commission are operating, constructing, or planning hundreds of other projects. This number is growing at an increasing rate each year. And this still is not all of the activity in the water-resource field. To mention another, the new Federal Highway Program, with all of its cuts and fills, will profoundly affect the characteristics of the nation's waters. Of particular interest to this group is yet another type of activity—dredging and filling of estuarine and coastal wetlands to provide for navigation channels or to make new sites for industry, commerce, and residences. Every one of the activities and every one of the projects affects fish and wildlife habitat to greater or lesser degree.

This big job has been made the main responsibility of the Branch of River Basins of the Bureau of Sport Fisheries and Wildlife, operating also in the interests of the Bureau of Commercial Fisheries and the Service generally.

These, then, are the proportions of the challenging task which the 163 men of our Branch are attempting to do. Fortunately, we don't have to go it alone. We ask for and receive cooperation and assistance from the State conservation departments and the other branches of our Service organization. For their helping hands, we are grateful indeed.

Obviously, River Basins is a streamlined, fast-moving investigational function. It has to be. When a research man tackles a problem, he continues his investigation until he finds his answer, no matter how long it takes. We do not have that opportunity. Our River Basins people must conduct scientific field studies which meet definite time limits set by the planning and construction schedules of the engineering agencies. Consequently, we are, perforce, a group of deadline meeters, operating constantly at flank speed. Somehow, in the brief time that we ordinarily have available for an investigation, we have to come up with recommendations that will protect fish and wildlife resources. Our men do it, day after day, and week after week.

To meet this challenge, River Basin Studies formulates what specific recommendations can be determined by the judgment of our field biologists in the time available for project investigation, but relies heavily on provisions in law or project-authorizing documents for reasonable changes—after the project is built—in project structures and operations. In that way, advantage can be taken of the latest techniques in fisheries and wildlife management throughout the life of the project.

In the brief, twelve year history of the Branch of River Basins, we have been preoccupied with building up our strength and staff and by attempting to keep pace with current project proposals. However, there is an ever growing list of projects whose basic authorization includes provision for these changes in operation and structure after they are built. This list and these provisions are like money in the bank for fish and wildlife conservation. They can be drawn upon throughout the life of these projects to provide for more effective conservation of these resources.

Our tremendous water program can be a threat to the very existence of the fishery resources of this nation if the conservation agencies don't do their jobs. Every mouthful of a clamshell bucket or a dragline scoop dug from the bottom of a stream or estuary takes away a piece of living space for the fishery resources of this nation and has other effects besides. Every fall of a control gate in a dam changes the regimen of the stream below it, and changes its fishery habitat characteristics.

What are we to do about it?

We have only one course of action. We simply must use all the knowledge and imagination we can muster to see that these projects are designed, built, and operated so as to result in the least damage to our fish and wildlife resources. We must also recognize that some of these projects have good potentials for the improvement and enhancement of fish and wildlife. We must capitalize on these potentials to the maximum extent. Finally, we must not hesitate flatly to oppose a project where we can demonstrate to the satisfaction of the Congress and the public that the adverse effects on fish and wildlife clearly overbalance the benefits to other interests from building the project. That, in broad general terms, is what we have to do. The next question is: How do we do it?

Fundamentally, our approach must be legal as well as biological. The water-development program of this country is carried out in accordance with laws adopted by our Congress. There are literally hundreds of these laws which cover water development generally, and water projects specifically and individually. Taken together, they establish the legal framework for the water-development program. It follows that a proper place for fish and wildlife in this program has to be obtained through legislative action and provisions in the project legal framework for fish and wildlife conservation.

One of these laws is the Coordination Act, adopted on August 14, 1946, sometimes known as Public Law 732, 79th Congress. The Coordination Act is the Magna Charta of River Basin Studies. What conservation authority we have for investigating and reporting on water projects is contained in this Act. It also provides the limitation on what we can do toward the conservation of fish and wildlife in the nation's water-project program.

Briefly stated, the Coordination Act of 1946 provides that there shall be an investigation by the Fish and Wildlife Service and the appropriate State fish and game agency of any project proposed by any Federal agency or any non-Federal agency under Federal license, for the impounding, diverting, or other control of the waters of any stream or other body of water. The purpose of this investigation is to determine the effects of the project on fish and wildlife resources and to formulate means and measures for incorporation in the project plan to prevent loss of, and damage to, these resources. The Act also provides that the report of the Fish and Wildlife Service shall accompany the engineering agency's project report when transmitted to the Congress, and that the cost of fish and wildlife conservation measures shall be considered as part of the cost of the project.

Be it noted that the Coordination Act is a permissive piece of legislation. It has no mandatory provisions binding on Federal agencies who license, construct, and operate water-resource projects. Consequently, the results for fish and wildlife conservation must be obtained largely by successful negotiation with these agencies. They, of course, are well aware of their legal option to adopt or reject any particular conservation measure. Under these circumstances, we can point

with some pride to the accomplishments under the Coordination Act. But, frankly, the Act in its present form is not nearly strong enough to maintain at an acceptable level the fish and wildlife resources needed to support the commercial and recreational interests dependent on them.

Here are some of the weaknesses of the Act. It has questionable application to dredging by the Corps of Engineers of navigation channels in the estuaries and coastal waters which are so important for commercial and sport fishery resources. It definitely does not apply to dredging and filling carried out by non-Federal interests under permit from the Corps. The Act is oriented toward prevention of damage and does not provide clear authority for construction agencies to take advantage of opportunities for the improvement and enhancement of fish and wildlife. Also, it has questionable application to the hundreds of projects authorized prior to 1946.

Last January, Ross Leffler, Assistant Secretary of the Interior for Fish and Wildlife, at the direction of Secretary Seaton, sent a draft of proposed amendments to the Governor of each state for review and comment. These amendments are designed to show up the weaknesses of the Act and to plug its loopholes. Within a short time thereafter, he received from each of the 48 Governors, or their authorized representatives, approving comments on the proposed legislation and a number of excellent suggestions for its improvement. Every national conservation agency of the nation has expressed approval of the proposed amendments.

Most importantly, these amendments would clearly authorize construction agencies to plan, build, and operate projects for the development and improvement of fish and wildlife, as well as for other purposes. They would authorize these agencies to acquire land for fish and wildlife purposes at Government projects. Significantly to the interests of the Gulf and Caribbean area, they would make the Act clearly apply to drainage and navigation projects of the type which are threatening the fishery resources in the estuaries of the Gulf of Mexico. The amendments would also make the Act apply to projects already authorized, no matter when the date of authorization, providing they have not been substantially completed. Taken as a whole, these amendments represent positive legislation which will give Federal construction agencies the authority to do a truly sound job in the fish and wildlife field. They will place fish and wildlife conservation on an equal partnership basis in resources planning.

Every man who makes his living, directly or indirectly, from the products of the sea or its adjacent coastal waters, has a tremendous stake in seeing that these amendments to the Coordination Act are adopted.

If the amendments are passed in the form proposed, we and you wi'l be in a far better position to see that projects like the Mississippi River-Gulf Outlet canal will do the least possible damage to important shellfish habitat, fin-fish nursery areas, and waterfowl marshes of the Gulf coast.

It's worth noting here that the basic plan on which the Mississippi River-Gulf Outlet project was authorized was completed in 1946, just a few weeks after the passage of the Coordination Act. The plan was developed without benefit of, or request for, an investigation by the Fish and Wildlife Service, or the Louisiana Wild Life and Fisheries Commission. This plan calls for building a ship canal from the vicinity of New Orleans to the Gulf of Mexico in the Breton Sound area. The canal will be about 70 miles long, 500 feet wide, and 36 feet deep. Its purpose will be to shorten the distance for ships and boats from the Gulf to the

City, and to facilitate navigation. The canal is likely to have profound effects on the important fish and wildlife resources of the area through which it will pass. Its construction will disturb the bottoms by dredging and deposition of spoil, and it possibly will change the salinity of the water.

After completion of the plan for this project in 1946, it laid on the shelf for 10 years. Then it was authorized in 1956. Funds were made available for the preparation of detailed plans and initiation of construction just a few months ago. Under current budgetary policies, we can undertake the investigation of a project like this only when funds are transferred to us for that purpose by the construction agency. When that agency has no project funds, as was the case on the Mississippi River-Gulf Outlet project for 11 years after the plan was completed, we obviously cannot get project funds transferred to us for our studies. It should be made clear that funds for investigation of this project were made available to us at exactly the same time, a few months ago, that project funds were made available to the Corps of Engineers. Obviously, of course, the construction plans on this project are much farther advanced than the studies of the Fish and Wildlife Service, because of the planning work that the Corps did back in 1946. However, Secretary Seaton has formally requested the Secretary of the Army to do everything possible to bring the fish and wildlife planning for this project into balance with the construction planning.

What can we expect on the Mississippi River-Gulf Outlet? Clearly, the project is not going to be blocked or stopped. It has been authorized, and the initial construction funds have been appropriated. What we must strive to do is bring about the modification of plans so that the project will do the least possible damage to fish and wildlife resources. To do this, we need the findings of research on the effects of changes in salinity, changes in currents, the dredging of bottoms and the deposition of spoil on the shellfishes and fin-fishes of the Louisiana coastal wetlands. The Bureau of Commercial Fisheries has recognized this need, and has already put in motion plans to have this research started.

The need for this research has been recognized by the Bureau of Sports Fisheries and Wildlife for several years, in view of the very large program of the engineering agencies for modification of estuarine fishery habitat along the Gulf coast and the South Atlantic seaboard. Arthur Marshall, then in our organization, discussed this need before the meeting of this Institute last fall at Nassau. We are most gratified that aggressive steps are being taken by the Bureau of Commercial Fisheries toward finding some of the answers we need to formulate conservation recommendations, not only for the Mississippi River-Gulf Outlet project, but also for the some 40 other projects along the Gulf coast alone, which are in prospect for the next decade under the aegis of the Corps of Engineers. Furthermore, every hurricane prompts new demands on the Government to plan barriers or other measures to block disastrous waves from our shores.

The Mississippi River-Gulf Outlet project is a prime example of the importance of proper timing in river basins work. The plan was prepared 11 years ago; the most effective time for conservation recommendations likewise would have been 11 years ago. By the same token, we need to be working now on projects that will go into construction status 10 or 15 years from now. To get the job done right, we need to be heard at every major step during the years-long route from the conception of an engineering plan, through all of the inter-agency review processes, through review by the Bureau of the Budget, through con-

sideration of authorization by the Congress, and through the process of submitting estimates and getting project appropriations.

We assure you that we are putting in our oar at each of these steps on projects now in the planning mill. But you will have to take this on faith, because these projects, many of them, will not reach the construction stage for a decade or more. Consequently, the results of our efforts will not be apparent until then. Nevertheless, what we do today will determine how effective we are 10 or 15 years from now.

The role of the Fish and Wildlife Service in its river basin studies work is to lock the barn doors 10 or 15 years in advance of the horse's disappearance. We hope that we have the wisdom and the foresight to do the job.

Plankton and Fisheries in the Gulf of Mexico[1]

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WE HOPE THAT BEFORE LONG it will be possible to start from Texas A. and M. a widespread survey of the plankton in the offshore waters of the Gulf of Mexico. Such a project could well be justified on academic grounds alone. Dr. Galtsoff has already reminded us that productivity studies in the open Gulf are amongst our most pressing needs. Clearly, considerable improvements in our current knowledge of standing crops and seasonal cycles of both phytoplankton and zooplankton will be necessary before such studies can become meaningful.

But the preparation of regular synoptic charts of plankton distributions may well also provide direct and indirect information of considerable importance to the Gulf fisheries; or, at least, this would seem likely from experience in the North Sea and adjacent waters.

Firstly, the use of automatic sampling gear from a variety of shipping should reveal concentrations of larvae in the plankton catches and so help to delimit more closely the spawning grounds of shrimp and commercially important fish. At the same time aggregations of species which are not at present exploited might be demonstrated by the distribution of their eggs and young. Unsuspected stocks of Blue Whiting, *Gadus poutassou,* were found by Henderson (1957) in this manner in the Atlantic, 200-300 miles west of Scotland.

Secondly, it seems likely by analogy with the North Sea that the natural fluctuation in the yields of the Gulf fisheries may be greatly effected by the interchange of water between the offshore and coastal waters and between the Atlantic and the Gulf. That is, by factors which, although they are tied in some way to these water movements, are not readily recognizable by conventional hydrographic techniques. As an example, one can cite the well documented collapse of the herring fishery in the western reaches of the English Channel during the 1930's (Kemp, 1938). Here, it was the younger age groups of fish which first declined in numbers, so over-exploitation could not account

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[1]Contribution from the Department of Oceanography and Meteorology of the Agricultural and Mechanical College of Texas, Oceanography and Meteorology Series No. 117.